Pam
Food
Supply

THE RACE BETWEEN PROCREATION AND FOOD PRODUCTION

J. GEORGE HARRAR

JAN 13 '68

THE RACE BETWEEN PROCREATION AND FOOD PRODUCTION

J. GEORGE HARRAR

President, The Rockefeller Foundation

Prepared from a paper presented
at the Spring Meeting of the
American Philosophical Society
in Philadelphia, 1965

THE ROCKEFELLER FOUNDATION
New York 1965

THE ROCKEFELLER FOUNDATION

111 WEST 50TH STREET, NEW YORK, NEW YORK 10020

Printed in the United States of America

Pam
Food
Supply

THE PURPOSES of human life are not fulfilled simply through the provision of appropriate quantities of foodstuffs to supply energy. The human experience achieves meaning only when the individual enjoys an opportunity to develop the full potential of his personality. Though life cannot be equated solely with food, it is, nevertheless, a hard fact that the former depends squarely on the latter, and that over half the world's population must occupy their full time and energy in growing the food they live on. This alone emphasizes dramatically that food production is basic not only to human existence but to the quality of human experience. The precarious balance between populations and their food supply represents a critical relationship which may well determine the course of history.

The subject of population is a fitting one for presentation before the American Philosophical Society. In 1751 the Society's founder prepared a manuscript setting forth his "Observations Concerning the Increase of Mankind, and the Peopling of Countries,"[1] and proceeded to share it with his fellow members. We know that Benjamin Franklin's ideas definitely influenced the thinking of Thomas Malthus, Adam Smith, and the English founder of the modern birth-control movement, Francis Place.[2] These men took a far more gloomy view of the world's population growth than did Franklin. Sanguine about America's rapidly growing population, Franklin surveyed his country's demographic future with confidence and equanimity because of a plentiful supply of land to support her large families.

764

In Franklin's day, the revolutions in industry, science, technology, medicine, and public health were hardly in their infancy in the Western world. Close on the heels of each revolution came major increases in the numbers of human beings.[3] These increases did not exert detrimental effects in the Western nations because the rise in numbers took place over a period of several decades and expanding economies were able to absorb a major portion of their populations. Moreover, population pressures in Europe were in part relieved by emigration to the less crowded regions of the globe. Today, standards of living in the advanced nations of the West have reached unprecedented heights.

When Franklin wrote his paper, 214 years ago, the population of the world stood at an estimated 700 million.[4] Today it is nearly 3.4 billion. Each week sees a *net increase* of over 1.3 million. To put it more forcefully still, this growth amounts to about 192,000 each day, or nearly two and one-quarter persons per second. If this growth rate of over two per cent continues to be compounded annually, the world's population will be more than doubled by the turn of the century.[5]

The job of simply providing bare subsistence for all these people is in itself one of frightening magnitude. The total implications of enormous populations, and the stupendous task of assuring meaningful experience and opportunity for all, might well cause men of good will to confess themselves helpless. Nevertheless, the task must be essayed with all the reason, understanding, and intelligence mankind has at its disposal.

The people of Western nations do not yet suffer the pangs of hunger or the extreme pressures of overpopulation. But in many of the non-Western nations, a dismaying degradation of the human experience worsens each day. The conditions in these nations might well be prophetic. The old feeling of fortunate people that the painful problems of faraway lands are too remote to be meaningful to them, is today unrealistic and unenlightened. As never before in history, the concerns of any nation become to some degree the concern of all nations.

The less developed areas of the world have several common denominators. Theirs are fundamentally agrarian economies, with rural classes largely isolated from the urban centers. Vast numbers of the rural dwellers live at extremely low standards. Most of these areas possess severely limited renewable and nonrenewable resources. All too many of their governments are politically unstable. An added deterrent to progress is that large segments of the population are illiterate or have had totally inadequate educational and training opportunities. Moreover, it is just these countries which are experiencing extraordinary increases in rates of population growth.

The nations which were formerly colonies, in the past had served principally to furnish food and raw materials to industrial nations.[6] They were long regarded not so much as societies in stages of evolution as sources of supplies for the expanding needs of the metropolitan powers who, in return, provided protection and certain other political and social services. Perhaps the first and key change in this situ-

ation was the extension into the less developed areas of advances in the fields of medicine and public health. These advances had doubled life expectancy in the West and soon began to increase the life span of people everywhere. Throughout the developing world, the expectation of life at birth is rising from the traditional level of 30 or 35 years prevalent only two decades ago, toward the more than 70 years characteristic of the most advanced Western nations.

Medical benefits have had the secondary effect of bringing about huge annual additions to the populations of the developing areas, along with large-scale social and economic disruption. From today's point of vantage, it may well be regretted that early advances in public health were not coupled with the foresight to initiate measures to help stabilize the populations that benefitted from them.

The adverse effects of rapid population increase have fallen most heavily on the nations least able to handle staggering numbers of new individuals. In many of the poorer nations the net rate of increase is more than 3 per cent per year. Even a rich nation would have a difficult task in accommodating that many new people annually. In 1900 the populations of the less developed regions made up about 67 per cent of the world total; in 1960 they comprised about 70 per cent; and in 2000, the population of these same regions will be almost 80 per cent of the world total. A 10 per cent increase over a forty-year period may not seem very ominous on paper, but numerically it represents the addition of almost 3 billion people to the less developed regions, but of only 436 million in the developed countries.[7]

A most frustrating phenomenon associated with uncontrolled and massive population growth is the soak-up effect. This is the discouraging situation in which herculean efforts to bring about economic development and improved standards of living are nullified by growing numbers. In its micro form, this effect can be illustrated by the subsistence farmer whose every improvement in efficiency of production is offset by increases in the size of his family. On a national scale this situation can doom a government's most careful planning for economic development.

Not only sheer numbers, but also the distribution of age groups puts a severe strain on poorer lands. In many of the underdeveloped countries, 40 to 45 per cent of the population is under the age of 15. The national economies of these countries must depend on the labor of only 50 to 55 per cent of their population, since another 3 to 4 per cent are too old to be productive. In most of the highly industrialized countries, the proportion of children under 15 is only 25 to 30 per cent and the economy may draw upon the productive capacity of 55 to 60 per cent of the population.[8]

Food production is similarly out of balance. The less developed areas, with 70 per cent of the world's people, produce only 47 per cent of the world's food grains, using .43 acres of land per capita to do so. The advanced nations, only fractionally as large in total land surface and with only 30 per cent of the world's people, grow 53 per cent of the world's grain, devoting .85 acres of land per capita to its production.[9]

Despite all the progress in science and technology of the

past 150 years, there are today many more people who live in hunger, misery, and deprivation than at the turn of the century. There is a tendency to emphasize the growing numbers of people who are enjoying more adequate standards of living each year, but the tragic fact is that the world's disadvantaged people are increasing in much greater numbers than those with rising living standards.[10] This year, half the world's population is hungry – either undernourished or malnourished. The Food and Agriculture Organization of the United Nations has estimated that there must be a global annual increase in food production of about 2.25 per cent above the rate of population growth to provide a decent level of nutrition for all the world's people. Thus a 4 to 5 per cent annual increase in the rate of food production will be required to provide an adequate diet not only for the estimated 1.5 to 2 billion who are now hungry, but also for the hundreds of millions of new human beings who will be born within the next few years.[11]

Clearly, measures must be taken now if the world is to retain any sort of balance between nutrition and numbers. Acceptable ways must be found to decrease population growth rates and, simultaneously, to increase world food supplies. These are the two fundamental and interrelated elements of the modern dilemma.

POPULATION STABILIZATION

To ACHIEVE a stable and controlled population growth rate must be a goal of modern society. In the past, sporadic

increases in mortality rates and a short life span interacted to control population growth. Modern civilization fights valiantly and continuously against famine and plagues, and in other ways seeks to prolong life and increase the dignity of the human condition. Voluntary reduction of births is the only road open to population stabilization. Its effectiveness depends on three essential factors: the level and intensity of motivation (the social factor); the utility and availability of procedures (the biomedical factor);[12] and the means of reaching promptly the myriad individuals who might wish to take advantage of available procedures (the organizational factor). Since World War II, the greatest advance has been in improving the biomedical factor. Given motivation, a family in a developed nation is now, more than ever before in history, likely to have access to some effective biomedical procedure.

The social factor still continues to impede rapid progress toward population stabilization. Cultural attitudes, religious beliefs and restrictions, economic limitations, family organization, and sexual practices are all resistant to change and loom large as obstacles to the control of population growth. This is the case even in the highly developed countries, where large segments of the public already seem to be well ahead of their leaders in the matter of family planning.

In all parts of the world in which population stabilization is of vital importance and especially in the heavily overpopulated areas, the missing element is organization and the development of patterns of operation to make generally available the concepts, information, and materials essential

to family planning. It is increasingly clear that many underprivileged and disadvantaged families, even though they may not be educated, welcome simple, inexpensive methods to effect family planning and to reduce the burden of families of excessive size. Leaders in the field believe that greatly stepped-up efforts to reach the millions of families who could profit through family planning would show prompt and ultimately spectacular benefits.

There are several encouraging indications that the world is slowly becoming aware of the dangers inherent in uncontrolled population growth. Long suppressed by various forces strongly opposed to any suggestion of family planning, the whole problem has now become the subject of a continuing dialogue, discussed openly in various forums throughout the world. Recently the Senate of the United States held a series of public hearings on the Gruening bill, which provides for two new assistant secretaries for population problems in the Department of State and the Department of Health, Education, and Welfare. These two public servants would concern themselves largely with the collection and dissemination of information on the activities of federal and state governments, and of foreign governments, in the birth-control field, and with stimulating the development and flow of new information.

Another promising development in this country is the recent Supreme Court decision which declared unconstitutional a Connecticut law of 1879 forbidding the use or sale of contraceptives. This decision guarantees freedom under the law to those people who wish to limit the size of their

families, but it does not abridge the freedom of others. The responsibility for family size has now been placed squarely where it fundamentally belongs in a democratic society – not on the state, but on each individual couple in its private capacity.

Among the states, since January, 1965, 11 legislatures have taken action to provide family planning services or to repeal archaic and obsolete birth-control laws. Since these 11 states include some of the nation's most populous areas, virtually half the population of the United States – around 100 million people – may now, under certain legal provisions, seek and utilize birth-control information and devices. The most recent example of legislative action is in New York, where the legislature has just removed from the statute books an 1881 law which, though in fact largely ignored, banned the dissemination of birth-control devices and information.

In some Asian countries, national governments have begun to sponsor active programs designed to reduce population growth rates. The Government of India incorporated into its Fourth Five-Year Plan (1966-1971)[13] a sterilization and intrauterine device program which has yielded significant data. It is expected that at least a million of these devices will be used during the next twelve months, with the ultimate hope that considerable progress may be made toward reducing India's annual population increase of 10 million. South Korea and Pakistan have also initiated programs directly aimed at family planning and population stabilization, using the intrauterine device as a primary

means. Japan, by means of a highly effective program of legalized abortion, succeeded in cutting its birth rate in half between 1947 and 1955, and recently other less drastic methods have found acceptance there.[14]

In Latin America, where the population is increasing faster than in any other region of the world, there is growing alarm over the high rate of induced abortion among women of the disadvantaged classes. This and other social and economic problems have served to focus increased attention on the perils of uncontrolled population growth and to provoke widespread and serious discussion of family planning. A dramatic example is the First Pan American Assembly on Population, held in Cali, Colombia, in August 1965. Among the participants in the Assembly were educators, doctors, sociologists, businessmen, and clergymen from all over the Americas. Never before in Latin America has there been open debate on such subjects as birth control and the relative merits of various contraceptive devices, and it is hoped that the Assembly will have far-reaching and beneficial results.[15]

Even in the Communist nations, government population policies begin to give some indication that they no longer strictly adhere to the Marxist-Leninist view that overpopulation is a problem only in capitalist nations and that a truly communist state, because its means of production are socialized, can accommodate an unlimited number of people and indeed should encourage a large population. China, with 700 million inhabitants, found its Great Leap Forward seriously hampered by the need to provide for an annual

population increase of 12 million. The government, after protracted debate within the party on an official population policy, now appears to advocate later marriage and smaller families.[16]

In December, 1962, the United Nations served for the first time in its history as the forum for an open debate on world population problems. A resolution entitled "Population Growth and Economic Development" was passed which expressed general concern about growing populations and their threat to economic development. Its passage was an important indication that many governments are reconsidering their previous stand on population increase and would not actively oppose international measures to examine its ultimate effects. Twenty-seven nations, including the Soviet Union, other members of the Communist bloc, and certain predominantly Roman Catholic countries, abstained from the vote and the resolution was passed 69 to 0, thus registering the decision of this international body that the whole problem should be further studied.

During the three and a half years since the resolution was passed, the U.N. Economic Commission for Asia and the Far East, the U.N. Population Commission, and an ad hoc committee established by the Secretary-General to advise on a long-range program of work in the field of population, have all been active in planning and holding conferences, making surveys and reports, and gathering data. It is now expected that a much stronger draft resolution will be placed before the General Assembly later this year, calling for assistance to be provided to any country requesting it

on the formulation and operation of family planning programs and other population policy measures.[17]

Other hopeful signs are the spontaneous activities conducted around the world by private agencies, to stimulate public interest in averting the consequences of unlimited population growth. In a number of the advanced countries, both private and government funds are being earmarked in steadily increasing amounts for research on the biomedical aspects of reproduction and on family planning. The funds allocated for such studies by the National Institutes of Health of the United States[18] have been modest at best but may well increase. Recently developed technologies make it possible to manufacture contraceptive devices at minimal costs; in South Korea, Taiwan, and India, plastic intrauterine coils can be mass produced at a cost of two to three cents each.[19]

The Malthusians and Neo-Malthusians, once labeled prophets of doom, who warned of the ultimate dangers of uncontrolled population increase, have of late been appreciated by more and more of the world's spokesmen who have come to realize the importance of population growth in determining man's destiny. Final success can come only when political and other leaders understand the necessity of continuing the support of research and education, and of developing organizations responsible for ever-expanding action programs.

Major attention should be focused on the young people of all nations. It is they who will determine the numbers of the next generation, who must comprehend the disastrous

effects of uncontrolled population growth on their and their children's lives, who must accept the fact that they themselves can make appropriate decisions, and who must have access to the techniques of family planning. Obviously, to reach them will require massive effort, which should be accompanied by other endeavors directed toward economic progress and expansion of educational networks.

In view of the important role of government in social action, it is obvious that national governments should take the lead in formulating and putting into effect policies and programs to encourage family planning. If general agreement on this point could be reached, it would be possible to establish national agencies, and a specialized agency within the United Nations system which would concern itself with all aspects of the population problem. Such an agency could even be empowered to assist nations in developing blueprints to solve overpopulation problems and in establishing action programs to help promote family planning. Currently the United Nations is limited to the dissemination of information, to training personnel for demographic studies, and to promoting public discussion. The World Health Organization, for instance, has not been allowed to consider the effects of population density on health because of disagreement on policy among member nations.[20]

Although we can hope for more rapid progress toward international recognition of the population problem and toward agreement on approaches to its solution, the battle is still far from won. Where the situation is most acute, it

is least understood. And although partial success may be won by persuasion and special incentives, the ultimate solution can be found only in universal understanding and social planning with world opinion united behind it. Any and all efforts to reduce the rate of population growth in the already crowded nations depend upon organized national effort involving extensive programs which would reach the public generally, acquaint people with the basic concepts of family planning, and facilitate direct action.

Nor do the advantaged countries have immunity against the population problem. If they are to avoid the crises which exist elsewhere, they will have to act now to preserve for future generations much of what they have enjoyed and to ensure continuing progress toward the fulfillment of the human experience. Failure to act intelligently and promptly can only bring ultimate chaos, as numbers eventually stifle both individual and collective enterprise.

If people of this generation fail to recognize the problem and do not take positive steps for its solution, their descendants may well look back upon this time as a golden age forever gone.[21] The path man treads today leads to diminishing importance of the individual and declining respect for human dignity. Along it lie inherent danger of greater world instability and increasing severity of life on earth for all mankind.

INCREASED FOOD PRODUCTION

If the prospect of achieving a stabilized population is melancholy, that for early and major improvements in worldwide food production is equally discouraging. The two components interact. The strong probabilities are that within 15 years world population will exceed 4 billion; that high density populations such as those in India, Pakistan, and China will double before current trends can be changed;[22] and that at the end of the century we will have achieved the dubious miracle of multiplying world population by a factor of ten in 250 years. In the face of a deficit food-production pattern in 1965, there is good reason to be concerned about the future.

It seems paradoxical that the knowledge, methods, and materials needed for efficient food production are available in plentiful supply at a time when half the world's citizens live on substandard diets. It is frustrating to realize that, from the standpoint of technology, world food production could readily be doubled or trebled without bringing one additional acre under cultivation. If agricultural potentials could be translated into realities in all lands, food could be removed from the list of man's worries and he could concentrate on limiting population increases and improving the quality of the environment through social and economic measures to benefit the individual. The formula is simple but, too often, the essential ingredients are missing.

Most of the advanced nations have learned that agriculture is, not only an art and a science, but primarily a busi-

ness. The agricultural industry not only satisfies man's hunger but supports his technologies. But without the introduction of the essential elements required for successful and continuing production, agricultural practice may become destructive.

In seeking to modernize their agriculture, the leading industrial nations have recognized their total dependence on efficient systems for general and specialized education and on broad applications of modern technologies. They have invested vast sums to make education available to all persons throughout the country and to provide cheap power, adequate transportation, accessible markets, and ready credit in support of the agricultural industry. Unmistakably, this is the industry which is fundamental to all other economic endeavors.

In contrast, the disadvantaged nations are commonly still bound to traditional practices in agriculture: farming solely as a way of life, as the simple reaping of nature's bounty. In these lands, agriculture has been a subsistence enterprise for centuries; today it contributes little to national economies. Efforts to hasten economic progress through heavy emphasis on nonagricultural industries, ignoring the agricultural sector, have usually led to increasing deficits rather than to the desired economic gains. The curious attitude, that agriculture does not require the same attentive effort and economic support given the mining, construction, and fabricating industries, must change if there is ever to be hope that the world can be adequately fed.

Poorer nations usually have inadequate communication

and transportation systems, and their rural populations are largely isolated. The farmer cannot readily sell his surplus products, nor can he easily buy the goods and services he might desire. As a result, he lacks incentives to increase productivity. The same isolation makes it axiomatic that the farmer is the last to benefit from social advances, particularly in the realm of education. Until farmers everywhere are able to understand and communicate, there can never be hope that food production will approach total agricultural potentials.

It is interesting that the factors which apply most directly to the problems of population stabilization are similar to those involved in agricultural production. Social, technological, and organizational considerations are of paramount importance in seeking to increase world food supplies. Here again, the technologies are the most advanced of the three, and if they could be applied generally, the food deficit could be corrected. The techniques of education and related social phenomena are understood, and they, too, if generally applied, could with relative speed advance the individual and collective accomplishment of rural populations. However, as with population control, the mobilization of knowledge and the organization of programs to be applied promptly and widely, represent the greatest single bottleneck to the satisfaction of world hunger. What is needed is increased understanding, not only among those who till the soil but also among their leaders, who often fail to appreciate the necessity for sound agricultural planning and practice and for the investment of adequate funds in support

of the development of the agricultural industry. Funds appropriated for public works, industry and commerce, and the military, are all too often out of all proportion to the woefully meager amounts provided for agriculture.

The panaceas offered for agriculture in underdeveloped nations are many, but none thus far has achieved its avowed purpose. At various times great emphasis has been placed on land reform, credit organizations, extension services, and mechanization. It is repeatedly stated that a broadening of the base of education must accompany these other developments.

Perhaps the basic reason for the failure of these prescriptions is the lack of realization that no single measure can correct the situation – that it is necessary to apply a variety of remedial measures in a timely and balanced fashion. Changes for the better can be expected only from well-coordinated efforts to improve the entire substructure on which modern agriculture rests – ready transportation, cheap power, high-quality genetic materials, effective marketing outlets, credit systems, and the like, and to provide greater educational opportunities at all levels. Finally, no country dependent on agricultural resources for economic growth can afford to ignore the necessity for mobilizing of science and technology in support of agriculture.

Successful agriculture requires intelligent and logical planning and execution. Theoretically, a few leaders with complete authority and with sufficient numbers of partially trained but highly disciplined people could execute such plans, but such authoritarian methods are not a part of mod-

ern democratic systems. Reliance must rest on rapid upgrading of the educational and economic levels of rural peoples everywhere. To do so will require herculean efforts, the sacrifice of certain national luxuries, and even, for a time, general austerity. Nations seeking to improve their economic and social positions will have to develop, often against great odds, elementary and secondary schools and colleges, in-service training, extension services, and other techniques to bring to isolated and disadvantaged rural communities the opportunity to learn and to apply learning to the improvement of production patterns as well as to daily life.

Many of the present deficiencies of agricultural production are clearly evident; so are their causes, and the remedies which might be applied over substantial periods of time. It is essential that these efforts be undertaken. But there are short-run possibilities for prompter accomplishment which should also be vigorously pursued. These will in themselves help support collateral efforts.

One direct and extremely important approach would be a gigantic effort to provide mineral fertilizers in adequate quantities wherever they can usefully be applied. Fertilizers can be manufactured readily and are easily transported.[23] Perhaps the most important subsidy that could be given to farmers throughout the world would be in the form of fertilizers containing nitrogen, phosphorus, and potassium. If all organizations interested in improving food production in the developing areas would unite in a project for doubling, trebling, or quadrupling the amount of fertilizer used,

the results could be spectacular. Surely there would be waste, surely there would be misuse, but once undertaken, the effort should grow each year with improved organization and the increased understanding by those who for the first time would learn the benefits of these essential elements. Organized on an international scale, with attention to the requirements of the nations concerned, and the assurance of their enthusiastic participation and support, a fertilizer campaign could well be a master key to unlock one door to greater production.

Obviously, fertilizer alone does not guarantee successful agriculture. However, when fertilizer and high-yielding varieties go hand in hand, the situation immediately brightens. One obvious but frequently overlooked essential for increasing production is continuous effort to develop improved crop plant and domestic animal varieties with yield potentials greatly in excess of average harvests. National average yields of cereal crops, even in the most advanced nations, always lag far behind maximum potentials; as record yields go from 100 to 150 to 200 bushels or more per acre, national averages rise only from 20 to 30 and to 50 or so bushels per acre. Given the higher genetic potentials of improved crop plants, average yields can continue to rise. They can also rise by improved crop management stimulated by the promise of greater economic gain.

At least one billion pounds of animal protein, which might be used to improve human nutrition, are lost each year as a result of animal diseases. The value of the meat in the market place is unrealized, and the effort and capital in-

vested in herds and flocks later lost to disease, are wasted. Veterinary science and animal pathology are international concerns, and if they could be marshaled, reinforced, and applied on an ever-expanding scale, it is certain that the results, in the form of larger supplies of meat and meat products for hungry nations, would be dramatic. Here again, a vast body of research information is still unutilized in many areas of the world which, if promptly applied, would greatly benefit animal production. Effective regulatory programs already in existence, if enforced generally, could immediately begin to reverse the trend in animal losses from disease. Man has fought malaria, yellow fever, smallpox, and other widespread human diseases to a standstill during the past fifty years. Similar organized efforts for the control of rinderpest, schistosomiasis, aphthous fever, East African swine fever, bovine pleuropneumonia, and other major infectious disease of animals, could produce incalculable benefits through increased food supplies.

Water has always been a limiting factor in the success of agriculture throughout much of the world. Many large land areas are unsuitable for agriculture because of too much water or too little. In many areas, crops fail one, two, or three years out of five because of drought. Unfortunately, there is no easy or cheap way to supply water to moisture-scarce agricultural lands. Investments in power, material, and manpower must be heavy. Ultimately, perhaps, almost unlimited sources of cheap power may help resolve both the problem of converting saline or brackish waters for agricultural purposes and of pumping

them long distances. In the meantime, continuing effort should be made to develop crop plants with improved drought tolerance and shorter growing seasons. This approach, along with improvements in water conservation and utilization, could effect substantial improvements in production in the dry lands of the world. Such an approach, however, requires a kind of sophistication that can only come through continuing research and its application by those able to take advantage of modern methods and materials.

The search for new sources of food supplies must be continued and even intensified. Investigators should seek for methods of increasing the productivity of saline, fresh, and brackish waters for human nutrition. Further research on microorganisms of critical importance to nutrition, on plant genetics and physiology, soil science, animal science, and disease and pest control, must be conducted. Continuing studies must be made of food-processing techniques and product utilization. The application of the engineering sciences to agricultural production has had magnificent success in the advanced nations, and in the future it can be expected that proven techniques could be adapted to other lands.

To sum up: much could be done, although real breakthroughs probably can come only as the result of changes in social attitudes. Time is running out; the world cannot afford the dubious luxury of severe underproduction on lands which could yield two to three or more times their current averages and which could help sustain the added

burden of millions of citizens who are now deprived of the opportunity to enjoy a reasonable standard of living.

CONCLUSIONS

THE POWERS of modern science are finite, and governed by the purposes to which man is willing to apply them. In terms of scientific knowledge and its application, man could decide what rate of population increase would be acceptable, and he could achieve this rate, or change it, at will. Similarly, insofar as science and technology are concerned, man could double or treble current annual world food supplies.

Most of the great advances in public health and medicine have not required the active participation of all the people. The masses could remain passive and still reap the benefits of scientifically directed disease control campaigns and public works.[24] The population problem cannot be resolved passively by reason of its highly personal nature and the necessity of individual agreement and active participation.

The barriers, then, are not technological but human. They are not the same everywhere, since social and economic conditions, cultures, and attitudes vary widely over the face of the globe. A common denominator would seem to be the lack of general agreement and determination to take steps to achieve clearly desirable human purposes.

Ultimate population stabilization can come about only through interactions within the entire society. Fractional accomplishment could at best delay the inevitable. Similarly, food deficits must be tackled nationally and internationally,

for progress in a solitary situation contributes little to solving the total problem. Both the population and the food problems can be solved only through the active participation of leaders and people who must learn to accept new ideas and practices and to discard outmoded or even destructive traditional beliefs.[25]

There may still be a chance to avert a Malthusian disaster. The auguries are not all unfavorable when viewed in terms of contemporary potentials for achievement. If the world's leaders in government, religion, education, and science become convinced of the need for action, agree upon appropriate methods, and take responsibility for the wide dissemination of information, as well as for the organization of positive effort, then there is still hope. At best, the apparently unequal race between human procreation and food production can be won only after an immense and prolonged struggle, during which man will be ever more precariously crowding the margin of safety.

Whatever is done must be begun soon, if we are to avoid the ominous situation where population numbers become so great and relative food supplies so inadequate as to bring about an unnatural rise in death rates and severe social deterioration. Man can still choose the kind of world in which he would like to live, and he can work toward it. The generations which follow will not have it within their power to make that choice if it is left until then. As members of the most intelligent species on earth, men ought to be able to foresee, on behalf of themselves and future generations the consequences of biological complacency and

social lethargy and to take timely steps to forestall the dire consequences which could result from blindly playing the numbers game.

REFERENCES

1 Benjamin Franklin, *Papers,* IV, ed. Leonard W. Labaree (New Haven, Conn.: Yale Univ. Press, 1961), pp. 225-234.

2 Norman E. Hines, "Benjamin Franklin on Population: A Re-examination, with Special Reference to the Influence on Francis Place," *Economic History,* III (1934-1937), 388-398.
Conway Zirkle, "Benjamin Franklin, Thomas Malthus and the United States Census," *Isis,* XLVIII (1957), 58-62.
Alfred Owen Aldridge, "Franklin as Demographer," *Journal of Economic History,* IX (1949-1950), 25-44.

3 Julian Huxley, "World Population," *Scientific American,* CXCIV (March, 1956), 65.

4 Annabelle Desmond, "How Many People Have Ever Lived on Earth?," *The Population Crisis and the Use of World Resources,* ed. Stuart Mudd (The Hague: World Academy of Art and Science, 1964), p. 40.

5 *Population Bulletin,* XXI (May, 1965), 37-38.

6 Sir William Slater, *Man Must Eat* (Chicago: Univ. of Chicago Press, 1964), pp. 69-70.

7 Lester R. Brown, *Man, Land and Food: Looking Ahead at World Food Needs,* Foreign Agricultural Economic Report No. 11 (Washington: U. S. Dept. of Agriculture, Economic Research Service, 1963), pp. 10-15.

8 United Nations, Economic and Social Council, *Inquiry Among Governments on Problems Resulting from the Interaction of Economic Development and Population Changes,* Report of the Secretary-General (E/3895/Rev. 1, Nov. 24, 1964) (New York, 1964), pp. 17-18.

9 Brown, *op. cit.,* pp. 48-59.

10 Richard N. Gardner, "The Politics of Population: A Blueprint for International Cooperation," Mudd, *op. cit.,* p. 348.

11 Raymond P. Christensen, "Problems in Economics," *Farmer's World,* U. S. Dept. of Agriculture Yearbook (Washington: Govt. Print. Off., 1964), p. 578.
World Food Congress, Perspective Sixty-three No. 28 and 29,

Radio Scripts Prepared by United Nations Radio, July 10 and 17, 1963. (Mimeographed.)

12 National Academy of Sciences, Committee on Science and Public Policy, *The Growth of World Population: Analysis of the Problems and Recommendations for Research and Training*, Publication No. 1091 (Washington National Academy of Sciences, 1963), pp. 20-36.

13 S. Chandrasekhar, "A Billion Indians by 2000," *New York Times Magazine*, April 4, 1965, p. 32 ff.

14 Irene B. Taeuber, "Japan's Population: Miracle, Model or Case Study?," Mudd, *op. cit.*, pp. 188-196.

15 *New York Times*, August 16, 1965, p. 11; August 22, 1965, Section 4, p. 3.

16 R. C. North, "Communist China and the Population Problem," Mudd, *op. cit.*, pp. 176-187.

17 Gardner, *op. cit.*
Proceedings and Resolutions, United Nations General Assembly and Economic and Social Council, 1963-1965.

18 U. S., Congress, House, Sub-Committee on Appropriations, *Hearings, Departments of Labor and Health, Education, and Welfare, Part II, National Institute of Health*, 88th Cong., 2d Sess., 1964, p. 88.

19 Frank W. Notestein, "World Population Determinants in the Future," *World Population and Food Supplies, 1980*, American Society of Agronomy Special Publication No. 6 (Madison, Wis.: American Society of Agronomy, 1965), pp. 23-30.

20 Sir Julian Huxley, "The Impending Crisis," Mudd, *op. cit.*, p. 10.

21 Sir Charles Darwin, "The Law of Population Increase," *Our Crowded Planet*, ed. Fairfield Osborn (Garden City, N. Y.: Doubleday & Co., 1962), pp. 29-35.

22 Notestein, *op. cit.*, p. 30.

23 Raymond Ewell, "Famine and Fertilizer," *Chemical and Engineering News*, XLII (December 14, 1964), 107-117.

24 Warren S. Thompson and David T. Lewis, *Population Problems* (5th ed.; New York: McGraw-Hill Book Co., 1965), pp. 509-525.

25 *Ibid.*, p. 509.

ADDITIONAL REFERENCES

Brown, Lester. *Increasing World Food Output: Problems and Prospects.* Foreign Agricultural Economic Report No. 25. Washington: U. S. Dept. of Agriculture, Economic Research Service, 1965.

Cépède, Michel, François Houtart and Linus Grond. *Population and Food.* New York: Sheed & Ward, 1964.

Darwin, Sir Charles. *The Next Million Years.* Garden City, N. Y.: Doubleday & Co., 1953.

Desrosier, Norman W. *Attack on Starvation.* Westport, Conn.: Avi Publishing Co., 1961.

Hauser, Philip M., ed. *The Population Dilemma.* Englewood Cliffs, N. J.: Prentice-Hall, 1963.

Hertzler, J. O. *The Crisis in World Population.* Lincoln, Neb.: University of Nebraska Press, 1961.

Sauvy, Alfred. *Fertility and Survival.* New York: Criterion Books, 1961.

Schultz, Theodore W. *Economic Crises in World Agriculture.* Ann Arbor, Mich.: University of Michigan Press, 1965.

—. *Transforming Traditional Agriculture.* New Haven, Conn.: Yale University Press, 1964.

U. S. Dept. of Agriculture, Economic Research Service, Regional Analysis Division. *A Graphic Summary of World Agriculture.* Miscellaneous Publication No. 705. Washington: Government Printing Office, 1964.